PB81-233835

# The Argo Merchant Oil Spill and the Sediments of Nantucket Shoals Research, Litigation and Legislation

Rhode Island Univ.
Kingston

Prepared for

Environmental Research Lab.
Narragansett, RI

Jul 81

U.S. Department of Commerce
National Technical Information Service
NTIS

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| | | |
|---|---|---|
| 1. REPORT NO. EPA-600/J-80-319 | 2. Journal Article | 3. RECIPI PB81-233835 |
| 4. TITLE AND SUBTITLE The Argo Merchant Oil Spill and the Sediments of Nantucket Shoals: Research, Litigation and Legislation | | 5. REPORT DATE July 1981<br>6. PERFORMING ORGANIZATION CODE |
| 7. AUTHOR(S) Eva Hoffman<br>James G. Quinn | | 8. PERFORMING ORGANIZATION REPORT NO. ERL N-X 9 |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>Graduate School of Oceanography<br>University of Rhode Island<br>Kingston, Rhode Island 02881 | | 10. PROGRAM ELEMENT NO. ACULIA<br>11. CONTRACT/GRANT NO. R 802724 |
| 12. SPONSORING AGENCY NAME AND ADDRESS<br>Environmental Research Laboratory<br>EPA - Office of Research and Development<br>Narragansett, Rhode Island 02882 | | 13. TYPE OF REPORT AND PERIOD COVERED Journal Article<br>14. SPONSORING AGENCY CODE EPA/600/05 |

15. SUPPLEMENTARY NOTES

This project has been financed in part by funds from the Environmental Protection Agency

16. ABSTRACT

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Contaminants and Sediments, Vol. I, Robert Baker Ed., Ann Arbor Science, pp 185-218 (1980)

17. KEY WORDS AND DOCUMENT ANALYSIS

| a. DESCRIPTORS | b. IDENTIFIERS/OPEN ENDED TERMS | c. COSATI Field/Group |
|---|---|---|
| | | |

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA 22161

| | | |
|---|---|---|
| 18. DISTRIBUTION STATEMENT unlimited | 19. SECURITY CLASS *(This Report)* unclassified | 21. NO. OF PAGES |
| | 20. SECURITY CLASS *(This page)* unclassified | 22. PRICE |

EPA Form 2220-1 (9-73)

PB81 233835

EPA-600/J-80-319
Journal Article

*Contaminants and Sediments, Volume 1, edited by Robert A. Baker, Ann Arbor Science Publishers, Inc., Ann Arbor, MI ©1980.*

CHAPTER 9

# THE ARGO MERCHANT OIL SPILL AND THE SEDIMENTS OF NANTUCKET SHOALS: RESEARCH, LITIGATION AND LEGISLATION

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## INTRODUCTION

On December 15, 1976, the tanker Argo Merchant ran aground on Fishing Rip of Nantucket Shoals off the coast of Massachusetts. After several days of stormy weather she broke apart releasing her entire cargo of $28 \times 10^3$ metric tons of No. 6 fuel oil into the ocean. Federal and state government agencies and the New England scientific community launched a massive study of the spill. Lawsuits were filed and a concerned populace demanded legislative action. This chapter reviews the research findings relative to the interaction of the Argo Merchant oil with the sediments of Nantucket Shoals, and the interaction of the contaminated sediments with the organisms living there and in the waters above; summarizes the legal action filed in the federal court system relating to this spill; and reviews the government legislation and regulations influenced by the spill.

## SETTING THE STAGE

### The Wreck Site

*Topography of Nantucket Shoals*

A chart of the Nantucket Shoals region is shown in Figure 1. The major feature of the relief is a system of northeast–southwest sand ridges, which are thought to be remnants of the former Nantucket peninsula [1]. The sand ridges, separated from each other by gravel-bottom channels, are aligned in the direction of the main ebb-flood tidal currents. On the crest of this shoal and in the adjacent channels are numerous sand waves, many of which are aligned at right angles to the main ridge. As they approach the crest of the ridge they tend to become more and more aligned with the ridge axis itself [2].

Nantucket Shoals is separated from Georges Bank on the west by Great South Channel, a Pleistocene drainage valley [3]. Today, the Great South Channel is used extensively as a shipping lane to Boston and nearby ports from all points south. The sediments on Fishing Rip were sandy with mean grain size diameters of 0.6–1.5 mm at the wreck site, the variation apparently due to the position of the samples relative to the sand waves on the ridge [4].

*Physical Oceanography of Nantucket Shoals*

The dominant currents in the Nantucket Shoals region are rotary tidal currents imposed on a minor nontidal current component, which apparently changes seasonally [5,6]. The Tide Table Chart of the National Ocean Survey indicates that the average velocity of the rotary tidal currents measured at Davis Bank (E side) varies between 0.3 and 1.7 knots [7]. The Atlantic Coast Pilot warns that the currents can be even stronger:

> "The currents in the area [Nantucket Shoals] are strong and erratic, reaching a velocity of 3 to 5 knots around the edges of the shoals. They are made erratic by the obstruction of the shoals, in some cases being deflected to such an extent as to cause the direction to change 180° from one side of the shoal to the other" [8].

It also warns that these tidal currents are appreciably influenced by the winds [8].

The average nontidal portion of the current system varies seasonally: toward the SE from December–February at less than 0.1 knot, toward the SW at 0.3 knots in March, and toward the NW at 0.2 knot the remainder of the year [6]. However, there is much scatter in these data from year to year [9]. These data have been confirmed recently by studies of the U.S. Geological Survey [USGS] using current meter arrays deployed close to the time the ARGO MERCHANT grounded [6]. According to the Bumpus sea-bed drifter study [9], the bottom drift is toward the northwest or west year-around.

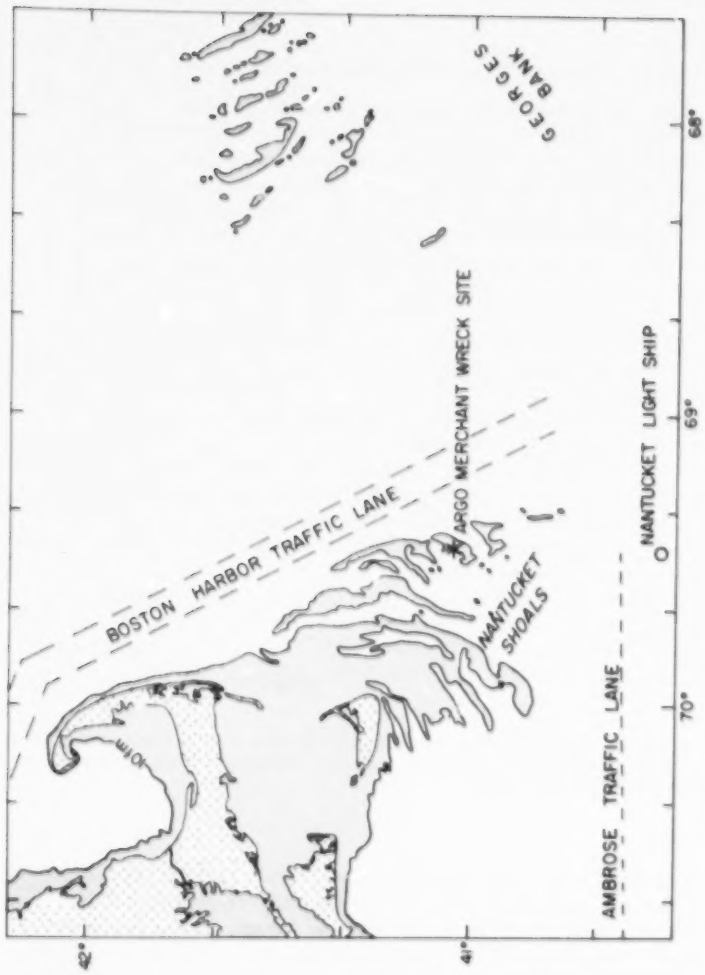


Figure 1. Nantucket Shoals and surrounding features, off the coast of Massachusetts.

Because the shoals are shallow, there is little or no temperature or salinity structure, indicating a well-mixed water column extending to the bottom [10]. Because of the shallowness, wind-induced mixing usually extends to the bottom, and surface waves are affected by bottom drag causing breakers to form.

*Implication of Sediment Movement on Nantucket Shoals*

Although no formal studies have been published regarding the movement of sands on Nantucket Shoals, several inferences can be made. It is obvious that the tidal currents can transport unconsolidated sands of the size range found on the shoals. Using Hjulstrom's [11] curves as a guide, transportation of sands less than 2 mm in diameter takes place during quieter times of the tidal cycle (0.3 knot), and sands greater than 2 mm are deposited. But at the height of normal tidal flows ($\geq$1.7 knots), erosion of all sands up to 7 mm in size takes place. On a theoretical basis then, one must conclude that the sand on the shoals is in nearly constant motion.

Indirect evidence of the dynamic nature of Nantucket Shoals is available from the observations of Navy divers sent to locate the bow section of the wreck. They compared the scene to a dust storm [12]. Bottom photographs taken by the U.S. Geological Survey during this period at a station on Georges Bank in 85 meters of water illustrate the scour and other changes in bottom microtopography [13]. Four weeks after the grounding a storm had resuspended so much material that the bottom was entirely obscured from view [13]. Transmission data obtained from this same instrument system revealed that bottom sediment resuspension and transport in this area is caused by surface waves, tidal currents and storms [13].

Thus, this series of shallow sand ridges, constantly changing, in an area where tidal currents change in speed and direction, and situated near a heavily travelled shipping lane, has become one of the greatest hazards to navigation along the east coast of the United States. The Atlantic Coast Pilot states simply:

> "Nantucket Shoals should be entirely avoided by deep-draft vessels when possible and by light-draft vessels without local knowledge on account of the treacherous currents" [8].

## The Wreck

The Argo Merchant (previously Arcturus, Permina Samundra III and Vari) was truly an international ship. She was built in Germany in 1953 and sold several times. At the time of her final voyage, she was owned by Thebes Shipping Co. (an American-owned Company), registered in Liberia, and sailed by a Greek captain with an international crew. She had been involved in several groundings and mishaps prior to her final one, and her casualty rate was about five times the average. She was 641 feet long, 84 feet wide, 28,870 gross tons, had a 35-foot draft when fully loaded, and at the

time of her grounding was carrying 7.6 million gallons of No. 6 fuel oil. More details concerning the history of the Argo Merchant are available in the literature [14]. On her last voyage, she was enroute from Venezuela to Salem, Massachusetts via Great South Channel (the Boston Shipping Lane). Exactly why the Argo Merchant ran aground on Nantucket Shoals is not known. Because the reasons for the grounding have implications as to whether the owners are liable, this matter is a subject of debate among the lawyers involved (see pp. 201–203). In any event, Argo Merchant ran aground on the Fishing Rip sand ridge of the Nantucket Shoals on December 15, 1976, approximately 11 miles west of the Boston shipping lane. The next day, the U.S. Coast Guard (USCG) assumed full control and responsibility for the Argo Merchant under the Intervention Convention.* A description of the Coast Guard's efforts to save the ship and her cargo has been described in detail by Winslow [14].

Pounded by heavy seas and high winds, the Argo Merchant began to spill oil on December 18, 1976, and began to sink at the stern the next day. Eventually, she broke apart amidships on December 21 and the bow section split again on December 22. Her entire cargo of about $28 \times 10^3$ metric tons of No. 6 fuel oil was released to the surrounding ocean over this five-day period. Both the stern and the mid-section sank near the original point of impact on the west side of Fishing Rip; however, on December 29, the bow section began to float off. By January 9, 1977, the bow section had disappeared from the surface and was relocated in mid-February resting on the bottom, on the east side of Fishing Rip, 1.5 miles southeast of the other two sections.

## RESEARCH ON THE BENTHIC ENVIRONMENT OF NANTUCKET SHOALS FOLLOWING THE ARGO MERCHANT OIL SPILL

At least seven federal agencies (from 29 different offices), four state agencies and seven universities and private institutions participated in studying the aftermath of the Argo Merchant oil spill. The original data and research findings of each group have been compiled and published in two books [15, 16]. This report centers on the benthic environment, the major body of research on which was accomplished by the University of Rhode Island's (URI) Oil Spill Response Team with cooperating investigators from the National Marine Fisheries Service (NMFS), the U.S. Coast Guard Research and Development Center (USCG) and McGill University. The field work portion of this work was funded by NOAA (with Department of Interior money) and the laboratory work was partially funded by NMFS and EPA.

*The Intervention Convention was international law that allowed the U.S. to take reasonable action to prevent or mitigate the threat of oil pollution if the vessel posed grave and imminent threat to the U.S. coast and/or U.S. interests.

### Argo Merchant Oil–Did It Sink?

Concern about the potential impact of the Argo Merchant oil on the benthic environment was voiced by the scientific community immediately after the grounding. This concern was well-founded because studies of two previous oil spills in New England waters (W. Falmouth and Searsport) had shown that contamination of the benthic environment had taken place, resulting in long-term impacts [17,18]. The sediments had served as a trap for the oil allowing dispersion to take place only at a slow rate, thereby affecting the benthic community for several years. Even after 10 years, the site affected by the W. Falmouth spill is still closed to shellfishing by the state of Massachusetts. There are several mechanisms by which oil can reach the sediments. With the Argo Merchant cargo, a No. 6 residual oil, there was concern that the oil after evaporation and/or dissolution of its lighter components might increase in density enough to simply sink. Whether this was actually happening was a point of much confusion during the first week after the spill [19]. An EPA memo distributed at a December 22 scientific coordination meeting stated simply that "much of the oil is apparently sinking" [20]. At the same meeting however, Jerome Milgram of MIT announced his findings that the oil had a density of 0.96 g/cm$^3$ [21] which did not increase substantially when distilled up to 210°C. He further found that about 20% of the cargo sample distilled below 120°C, representing the light distillate cutter stock routinely added to No. 6 fuel oil to improve its handling characteristics [15]. Dr. Milgram had obtained the only sample of the cargo and two of the three surface oil samples obtained. Later gas chromatographic analysis of the oil confirmed the presence of the lighter components.

Yet there are other ways oil can become incorporated in the sediments: (1) Oil can enter the sediments by adsorption of the oil on resuspended sediment, so that the density of the oil-sediment mixture becomes heavy enough to sink [22-24]. (2) Surface oil can come in direct contact with the sediments and there become associated with the sediments for varying periods of time [25]. This is most frequently observed at the intertidal zone or under extremely stormy conditions, i.e., W. Falmouth oil spill; and (3) Oil droplets can be injested by zooplankton and become incorporated in heavy fecal pellets, which sink to the bottom [26].

Therefore, there was some evidence that the Argo Merchant cargo would not sink by itself, but there was no way to predict the significance of the other possible mechanisms without actual field observations.

### Areal Distribution of the Sediment Contamination

The University of Rhode Island conducted four cruises to the Argo Merchant wreck site area under the sponsorship of NOAA. The first two cruises were benthic surveys covering a 1000 m$^2$ (nautical) area in the area of Nantucket Shoals and the southern part of Georges Bank. Rapid onboard screening of the sediments by USCG personnel revealed that contamination of the

sediments was limited to the wreck site area. The third cruise of this series was conducted to examine in finer detail the extent of the contamination in the wreck site area (Figure 2). The sediments were found to be significantly contaminated (>20 μg HC/g) at three locations [27]. Two of these stations were located at the wreck sites: Station 59 at the original wreck site (now the location of the stern and mid sections); and Station 70, the location of the bow section. The third station (Station 56) is located 3.2 km SE of the bow section in the channel adjacent to Fishing Rip Shoal. Traces of petroleum were found in the channel to the south and east of the wreck. These findings indicated that in February 1977, two months after the wreck, significant contamination extended at most 3-4 km from the wreck site in a SE direction. Traces of contamination (0.5-2 μg/g) extended 3-5 km from the wreck in the E and SW directions. At most, this would indicate that in February, only a 10-15 $km^2$ area of sediments were contaminated out of the 4000-$km^2$ area surveyed. The highest concentrations of Argo Merchant oil (122 μg HC/g) were found near the bow section [27].

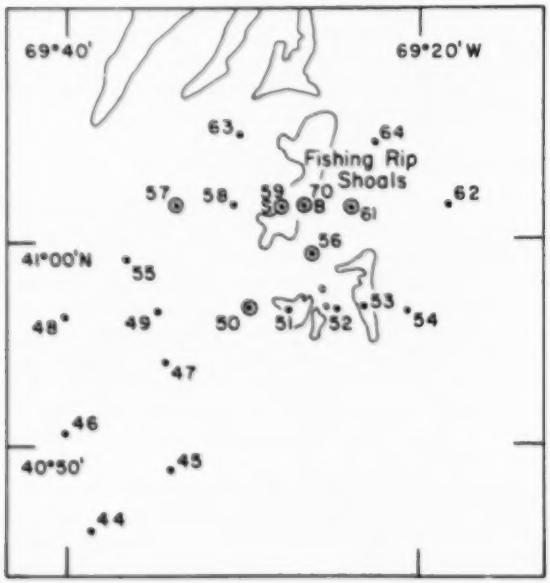


**Figure 2.** Station locations, EN-005, February 22-27, 1977. Argo Merchant bow was at station 70; Argo Merchant stern (original wreck site) was at station 59. Stations at which oil was observed (by URI and the Coast Guard) in the sediments are circled. Ten-fathom contour is shown [27].

## Nature of the Sediment Contamination

### *Tar Particles in the Sand*

It was found that most of the petroleum contamination in the wreck site area was due to the presence of minute tar particles or oil droplets* inhomogeneously mixed into the sand [4,27]. Microscopic examination revealed that the tar particles were in the size range of 0.03–2 mm in diameter, and that there was little tendency for the oil to coat either the mineral grains or shell fragments [4]. Only occasional sediment–particle interaction was observed. When these tar particles were physically removed from the sample it was found that these tar particles contained from 83% to >99% of the total hydrocarbons in the sample [28]. The oil droplets were found to be still quite buoyant and were observed to float free of the sediment matrix whenever the sediments were stirred with seawater or biological preservatives [4,28]. Also, the hydrocarbons in the tar particles removed by tweezers from 3 out of 4 sediments samples examined in this way matched very well with the cargo sample [27]. Since the contamination was in a form not readily seen except by close examination, there were reports from Navy dives that took place in this time frame (two months after the spill) that the bottom was clean [4,15]. This led to some confusion especially to the press over whether the sediments were "clean" or "contaminated" [12]. The sediments may have appeared clean to the divers who viewed them from a distance, but microscopic and close examination coupled with chemical measurements revealed the contamination.

### *Inhomogeneity of Distribution*

Chemical analysis and visual observations revealed that the tar particles were inhomogeneously mixed into the sand in February, two months after the spill. The chemical analyses showed that the petroleum hydrocarbons were not present uniformly around the area, but were quite patchy. The patchiness could be found not only as a function of station-to-station distance scales (1–2 km) but also within replicate grab samples less than 100 meters apart [27]. For example, at the bow wreck site (Station 70) replicate grab and core surface sediment samples contained 12.8, 10.2, 118, 1.9 and 2.7 μg HC/g, a variation over two orders of magnitude [27]. The mean sediment grain sizes on four of the grab samples collected at Station 70 were 1.6, 1.3, 0.9 and 0.8 mm [4].

Pratt [4] has speculated that these changes in sediment grain distribution between replicate grab samples may be the influence of microtopographic features of the shoal. One replicate grab could have been collected at the crest of a sand wave and the next in a trough. In any event, patchiness in

*The terms "tar particle" and "oil droplet" in these studies can be used interchangeably, for the distinction between the solid phase and the liquid phase depended on the temperature at which the observations were made. With cold or frozen sediment samples, the oil was solid; at laboratory room temperature, it was a viscous liquid.

hydrocarbon concentrations in the area is accompanied by apparent patchiness in the physical character of the sediment, both due to the highly physical nature of the shoals. In this study, there was no apparent relationship between sediment grain size and hydrocarbon concentrations at Station 70 [4,27]. Chemical analysis of the sediment samples showed that the tar particles were mixed inhomogeneously into the sand, even within the same grab sample (30 cm across). Replicate analysis of surface sediments from the same sample container yielded values of 118, 69.7 and 35.7 μg/g of hydrocarbons, though usual reproducibility for this type of analysis is on the order of ±12% [28].

Not only were the tar particles inhomogeneously distributed areally, but vertically as well. No consistent trend of hydrocarbon concentration with depth in the sediment was found [27]. For example, in two of the grab samples at the bow section the hydrocarbon concentrations were fairly constant with depth; while in two other grabs, the higher hydrocarbon concentrations appear in subsurface sediments. At the stern section, some of the grabs show their most elevated levels at the surface. The conclusions regarding the depth of sediment contaminations were not very strong, and it could only be said that contamination of some of the sediment extended at least 8–13 cm in depth [27]. Considering the active physical nature of the shoals, there is a possibility that some of the sediments in the area could be contaminated significantly deeper than this.

### Impact of Contaminated Sediments on the Water Column

#### *Oil Droplet Size Distribution Study*

As mentioned previously, some of the oil droplets or tar particles found in the sand were still quite buoyant and dislodged on agitation [4,29]. Further, Pratt [4] noted that more of the oil droplets floated free of the sediment during storage and sorting of benthic animals from the sediment. On the same cruise when the sediment samples were collected (February 1977, two months after the spill) water samples were also collected by Cornillon and his colleagues [30]. One liter from each sampling depth (1 meter, 6 meters, bottom) was filtered through Millipore® filters ranging in pore size from 0.3–8 μm. The filters were then examined microscopically for oil droplets in the manner of Forrester [31]. Cornillion [30] found oil droplets in the water column at Station 59 (the stern wreck site), at Station 70 (the bow wreck site) and at Station 58 (1 mi SW of the stern wreck). Three types of oil droplets were seen: oil droplets with no sediment in or adhering to the droplet; oil droplets with sediment particles inside (mostly oil); and sediment coated with oil (mostly sediment). The oil droplets without sediments were found in the surface samples whereas the oil droplets associated with sediment were found in the samples collected 6 meters from the surface and at the bottom. In addition, the location where the droplets were observed in these various depths of the water column was similar to that of the contaminated sediments.

At the time this cruise was conducted, the surface slick had been absent from this area for at least a month and presumably any oil droplets resulting directly from the surface slick would have dissipated. The best explanation for the presence of these droplets two months after the spill is the dislodgement of oil droplets from the sediments by the turbulence on the shoals. Incidentally, the Argo Merchant grounding occurred two months before the Bureau of Land Management Chemistry Baseline Cruises (contracted to Energy Resources Co. of Cambridge, Massachusetts) began examining the chemistry of the seawater and sediments of Georges Bank. They found elevated levels of hydrocarbons (HC) in the water column throughout the region on their February, 1977 cruise, as compared to their later data collected in May, August and November of 1977 [32]. At the time these data were presented at the Argo Merchant Symposium in January, 1978, it was unknown whether the elevated hydrocarbon levels in the water column in the winter of 1977 were due to normal shipping operations, or that the increase was in fact caused by the Argo Merchant oil spill affecting the hydrocarbon burden of the water column throughout the entire region [32]. On the recommendations of the Chemistry Workshop following the Argo Merchant Symposium [33], Energy Resources Co. received additional funding to conduct a followup cruise to determine if hydrocarbon levels were elevated in winter or if February 1977 was atypical due to the oil spill. The data from this cruise in February 1978 indicated that the values were low, similar to the November 1977 data, thus suggesting that the hydrocarbon values in February of 1977 were indeed atypical and higher than usual for the region [34].

The sediments of the southern part of Georges Bank were found to be uncontaminated by Argo Merchant oil on previous URI cruises. This indicates that the Argo Merchant oil may have gotten into the water column by two different mechanisms: oil droplets dislodged from the sediments [30] and "dissolved" or "water accommodated" hydrocarbons persisting throughout the region [34].

*Oil Droplets and Zooplankton**

Plankton tows were also conducted on R/V Endeavor on our February, 1977 cruise to the wreck site at the same stations the sediment samples were collected. These studies were jointly conducted by NMFS, McGill University, the U.S. Coast Guard Research and Development Center and URI. An areal survey of the zooplankton and its potential contamination was reported by Polak et al. [35]. In February, Polak and her colleagues [35] collected zooplankton with paired Bongo nets with mesh sizes of 0.333 and 0.505 mm. A portion of each sample was removed for histological examination and the remainder was analyzed by UV fluorescence for petroleum content. (It should be noted that these plankton nets will also collect phytoplankton, particulate matter [35,36] and even oil droplets [31,37]. Evidence indicates

*In this case, "zooplankton" refers only to holoplankton. Fish eggs are treated separately.

that hydrocarbons can be adsorbed by the net, thereby contaminating the plankton [37]. An attempt to correct for hydrocarbon adsorption was made in Polak's study by attaching clean swatches of net material and correcting the results based on the analyses of these swatches [35].) They found contaminated zooplankton at most stations within a 10-km radius of the wreck site. They noted both external and internal fouling of the zooplankton confirming the earlier results of Maurer [38]. While there is no direct correlation between the concentrations of oil found in the zooplankton with the amounts found in the sediments or the number of oil droplets found in the water column, the general area affected is quite similar. Again, it is postulated that the turbulence of the shoal waters caused resuspension of contaminated sediments and/or oil droplets to be dislodged from the sediments and the zooplankton were thus contaminated. Both UV fluorescence [35] and gas chromatographic analysis [36] indicated a good match of the zooplankton hydrocarbons in February with Argo Merchant oil.

There were several possible biological and ecological implications of the zooplankton results. Conover [26] reported the copepod segment zooplankton population ingesting oil droplets following the Arrow Bunker C oil spill. The oil apparently passed through the intestines of the copepods essentially unchanged and had no observable effect on the organisms themselves. Other workers have also observed zooplankton feeding on oil droplets [39]. Yet several other studies have shown that zooplankton can uptake and concentrate petroleum in their tissues [40,41]. No studies of toxicity have been conducted on zooplankton with No. 6 fuel oil, but several studies have shown that lighter hydrocarbons (i.e., from No. 2 fuel oil) can adversely affect the organisms [42,43]. It is not advisable, however, to compare these studies investigating zooplankton behavior as a function of concentration of water-soluble oil components to this particular case, where the form of contamination was oil droplets.

There was more concern that the contaminated plankton would be eaten by larger predators and thus enter the food chain (see reviews in Wolfe [44] and Malins [45]). An analysis of stomach contents of various fish caught in the Nantucket Shoals-Georges Bank area soon after the wreck revealed that zooplankton were being eaten by several varieties of fish, including alewife, dogfish, skate, cod, pollock, silver hake, red hake, sculpin and flounder [46]. Although the potential for transfer of pollutant hydrocarbons up the food chain existed, there is only weak evidence that such contamination occurred. Only 37 of the fish caught during this period were subjected to chemical analysis of stomach content (only those stomachs suspected of having oil content [8]) and three of these showed some form of gut content contamination by Argo Merchant oil [47]. Others had anthropogenic hydrocarbon contamination, but not from the spill source [47].

*Fish Egg Contamination*

Perhaps the most potentially severe impact of the Argo Merchant oil spill was the mortality of developing cod and pollock eggs due to contamination

by the oil [48,49]. At least some was in the form of tiny oil droplets (see photos in Longwell [48] and Longwell [49]. Obviously, it is not known whether these oil droplets included some of those released by the sediments. Since this study was done shortly after the wreck, the oil droplets could have also been from the surface slick. The NMFS is continuing to monitor cod and pollock fish stocks in an effort to determine what effect, if any, the fish egg mortalities had on the year class. The mortalities of fish eggs is often mentioned as the most serious environmental effect of the Argo Merchant oil spill.

### Impact of the Oil in the Sediments on the Benthic Organisms

There was little emphasis, e.g., funding, given in the URI contract from NOAA to determine the effects of oil on the benthic organisms of the area. Therefore, only preliminary data are available on this topic. Further biological examination of the samples collected on our cruises has recently been funded by NMFS. In February and July of 1977, one half of each sediment sample was preserved by biological archival. Pratt [4] observed oil in the guts of interstitial harpacticoids and a polychaete species and adhering to the appendages of a burrowing amphipod. He could not tell if these interactions with the oil had affected the organisms in any way. Compared with data taken in July, he found that in February, the density and diversity of the interstitial benthic animals at the wreck site was lower, but due to lack of previous seasonal background data, he could not distinguish whether the lower populations found in February were the result of natural seasonal variations. Sanders [50], reported a threefold decrease in the numbers of organisms found in the sediment at stations near the wreck compared to samples collected in an uncontaminated area shortly after the wreck. He cautioned that "this by itself does not mean possible serious biological damage may be occurring . . ." [50]. He suggested close seasonal surveillance of the area to determine this [50].

Brown and Cooper [51] examined the macrobenthos of the area in February of 1977 and found 1 in 33 starfish with black tarry masses in the bruccal cavity; 1 of 16 mussels with black tarry spots inside the shell; and 2 crabs with black residues in their digestive tract. The crab stomachs were later analyzed by gas chromatography in our lab and neither matched the Argo Merchant cargo. The oil could have undergone biological and chemical weathering or could have been from other sources.

There was some evidence that biodegradation of the oil was taking place in the sediments. Changes in the benthic flux of $O_2$ and $NH_3$ were observed by Rudnick [52]. These experiments, conducted on subsections of box cores collected for sediment analysis, revealed that the $O_2$ uptake was higher for the oiled cores than the controls. It was suggested that increased bacterial activity in the oiled cores was responsible for the difference.

**Oil, Nantucket Shoals and Time**

In July 1977, seven months after the spill, we rented a fishing boat (F/V Sideshow) and returned to Fishing Rip to collect sediment, benthic organisms and zooplankton. We reoccupied several of the stations we visited in February on R/V Endeavor. Only low levels of hydrocarbons (less than 0.2 $\mu$g/g) were found in most of the surface sediment samples. At only one station (bow wreck site) were petroleum hydrocarbons detected (0.4–0.6 $\mu$g/g), and these did not match the Argo Merchant cargo [27]. The hydrocarbons could have come from noncargo Argo Merchant sources, i.e., hydraulic fluids, ship's fuel etc., or from some other source altogether. In addition to the clean surface sediments, we found no contaminated zooplankton [35,36]. Clearly, the zooplankton we found at the site in July were not the same population of zooplankton found in February. Therefore, we cannot assume that the zooplankton cleaned themselves up between February and July. One can say only that the factors causing sediment and zooplankton contamination in February had been mitigated by July. Seven months after the spill, the slight effects noted on the benthic organisms in the area in February, were entirely gone. No oil or evidence of oil damage was found in any of the organisms [4,51]. However, there was circumstantial evidence that the stern section, or perhaps sediments near it, were still leaking oil because of a thin oil sheen in July, 1977 on the water surface over the stern wreck location [51]. A similar sheen was again observed by the Coast Guard in August of 1977 [53].

What was the fate of the oil in the sediments of Nantucket Shoals? There are several possibilities, but good evidence exists for only the first mechanism.

1. There is evidence that the sediments were releasing their small oil droplets into the water column forming tiny sheens when they reached the surface of the water. From here the oil would undergo the similar fate to the rest of the surface oil (evaporation, dissolution, oxidation, biodegradation, transportation away from the wreck). There are other possibilities, which we were not able to address.
2. The contaminated sediments could have been buried. Since we analyzed sediments in July only as deep as 10 cm, and since turbulence could rearrange sediments considerably deeper than this, the possibility of burial cannot be ignored.
3. The contaminated sediments could have been transported far away from the wreck site by the time we returned to the site in July. Indeed, sea bed drifters released at the wreck site in February had already begun to wash up on the beaches of Nantucket and Martha's Vineyard by June–August, 1977.* The drifter study indicated a net drift of 0.3–0.6 nautical mi/day [55].
4. The hydrocarbons in the sediments could have been biodegraded. The first three mechanisms and possibly the fourth would have been all enhanced by the high degree of physical activity on the shoals.

*A series of tar balls washed up on the beaches of Nantucket, Martha's Vineyard, Cape Cod and Rhode Island in March–April 1977. These were shown not to have originated from the Argo Merchant [54].

### How Did the Oil Get into the Sediments?

Among the various unanswered questions raised by the research on the Argo Merchant spill is how the oil got into the sediments. It is generally agreed that the oil did not sink in the two months following the spill. Certainly the density measurements of Milgram [21] and the observations concerning the buoyancy of the oil droplets in the sand [4,27] support that conclusion. Because the greatest concentrations were found near the wreck sites [4], the preliminary answer given by NOAA [15] was that the movement of the tanker's partially sunken bow section after it sunk as it dragged itself over the shoals mechanically worked the oil into the sand, and this sand was then transported by the bottom currents. If this were the case, one would have expected to find contamination on the top of the shoals between the original wreck site and the final resting place of the bow section. But R/V Endeavor has a draft of 18 feet, and it was not safe for us to examine sediments between the two wreck sites in February to evaluate this theory. When we returned in July on the fishing boat (draft of 6 feet) we collected five sediment samples on a transect between the bow and stern sections. As mentioned earlier, we found traces of petroleum hydrocarbons at the bow, but no evidence of petroleum hydrocarbons in the surface sediments on the shoals. Because there is no reason to believe that sediments on top of the shoals contaminated by the bow dragging over them would still be there seven months later, the theory is still viable. We would like to propose another similar mechanism—the sand blasting theory. As the wrecks sit on the bottom, they are being continually bathed by moving sand caused by the turbulence. This sand could dislodge oil and deposit a portion of it nearby and the currents would disperse the rest. The theory would account for the highest surface sediment contamination being found at wreck sites proper. This continual sand blasting of the wreck would also explain why traces of petroleum contamination in the sediments at the bow were found in July but no where else.

It was estimated that a maximum of 0.5% of the total oil spilled was incorporated in the sediments [27]. While this potentially represented a large quantity of oil, it is clear that on a mass balance basis the sediments of Nantucket Shoals were not the major sink for the Argo Merchant cargo. But the slow release of the small droplets into the water column resulted in contamination of biological species there for at least two months after the surface slick had departed. Seven months after the spill the surface sediments in the area were clean, and oil droplet interaction with the plankton there was no longer observed.

## LITIGATION IN THE WAKE OF THE ARGO MERCHANT

Legal action began on December 18, 1976, the very day the Argo Merchant began to spill oil. Two of these lawsuits involved claims based on

ecological damage. Damage to the benthic environment is mentioned by both complaints. On December 20, 1976, anticipating even further lawsuits, Thebes Shipping Inc., the owners of the Argo Merchant, filed a petition in U.S. District Court in New York City for exoneration from, or limitation of, liability for any damages resulting from this voyage. On this day the Court signed an order restraining the beginning or prosecution of actions against Thebes and/or Argo Merchant, and also requiring all claims be filed in the limitation of liability action by February 14, 1977.* Because all the other legal actions awaited a decision on the Thebes petition, we will first discuss this petition, the laws involved, the arguments of each side, and the future implications of this action.

### U.S. District Court of the Southern District of New York: In the Matter of the Complaint of Thebes Shipping Inc. as Owner of S. T. Argo Merchant, for Exoneration from or Limitation of Liability (76 Civ. 5638 TPG)

*Who and Why*

Thebes Shipping Inc. (hereafter referred to as Thebes) filed a petition to limit its liability according to the provisions of the U.S. Carriage of Goods by Sea Act (46 U.S.C. 1300-1315) [56]. This law states that the owner of the vessel is liable for damage unless the accident is caused by the excepted perils listed in the act. The law states concerning one such peril [56]:

> 2. Neither the carrier nor the ship shall be responsible for loss or damage arising from
>
> a. Act, neglect, or default of the master, mariner, pilot, or the servants of the carrier in the management or in the navigation of the ship (46 U.S.C. SS1304).

Another applicable law, The Limitation of Shipowners' Liability Act (of 1851) provides in part that [57]:

> The liability of the owner of any vessel . . . for any act, matter, or thing, loss, damage, or forfeiture, done, occasioned, or incurred, without the privity or knowledge of such owner . . . shall not . . . exceed the amount or value of the interest of such owner in such vessel, and her freight then pending. (46 U.S.C. S183(a) [57].

Precedent court decisions have ruled that errors in navigation are not within the owners' privity or knowledge [58]. Thebes' petition to the Court thus seeks a ruling limiting Thebes' liability for all damages to the value of the ship and the cargo, which was zero at the conclusion of the voyage under consideration.

*This apparently has become . . utine procedure in admiralty cases. However, one claimant, the Nantucket Conservation Foundation, feels the order restraining prosecution of Thebes by other courts is unconstitutional.

By the Court's deadline of February 14, 1977, seven parties filed claims as interested parties in the liability question. They were the U.S. Government, the State of Rhode Island, the Commonwealth of Massachusetts, Continental Insurance Co., Northeast Petroleum Corp., the Nantucket Conservation Foundation, and a coalition of New England fishing interests [58].

The U.S. Government was an interested party because it had expended approximately $2.5 million [59] in saving the crew; efforts to save the ship and her cargo; monitoring and predicting the movement of the slick; and conducting scientific research on the behavior of the oil and on the ecological damage of the oil on the environment. The U.S. Government was seeking at the time to recover part of these expenses through TOVALOP (Tankers Owners Voluntary Agreement concerning Liability for Oil Pollution), of which Thebes was a member. TOVALOP is an insurance fund for tanker owners, which pays national governments for any monies expended in efforts in saving the crew, the ship or cargo; expenses incurred by the government in cleaning up the spill; and such monitoring as is necessary to be prepared for any landfall of oil (not scientific or impact studies) [60]. The U.S. Government estimated that these expenses at approximately $1.8 million [59] and filed as a claimant in this limitation of liability petition by Thebes in case a satisfactory settlement was not reached with TOVALOP [61]. Eventually, TOVALOP settled with the U.S. government for $1.1 million of these expenses. As part of this settlement, the U.S. Government withdrew as a claimant in the Thebes petition.

The states of Massachusetts and Rhode Island, which also filed as claimants, were reimbursed for their expenses ($20,000 for Massachusetts and $5,000 for Rhode Island) [62] by the U.S. Government from the TOVALOP settlement. They also withdrew as claimants following the U.S. Government-TOVALOP settlement.

Continental Insurance Co. filed as a claimant because it had insured the cargo. Since the cargo was lost, it reimbursed the cargo "owners." In shipping the cargo from Venezuela to Salem, Massachusetts, the cargo would have normally gone through four owners: the Venezuela Petroleum Association (the refinery in Venezuela); Cibro Sales and Holborn Oil (both brokers); and Northeast Petroleum Corp. (who had contracted to buy the oil). Because none of these four wanted to claim that they owned the oil at the time of the grounding (apparently fearing lawsuits or legal action against the cargo owner), Continental Insurance Company paid the claim under a legal agreement in which none of the companies had to admit ownership [14]. Thus Continental Insurance Co. had paid the claim of the cargo owners (approximately $2.2 million) and then filed as a claimant because they sought eventually to recover this amount from Thebes.

Northeast Petroleum Corp. filed as a claimant only as a contingent in case it became involved in a lawsuit simply because it had contracted to buy the oil [63]. Although in retrospect this event would seem unlikely, at the time these claims were filed the atmosphere in New England was not friendly to anyone even casually involved. So it filed as a claimant simply for protection.

The Nantucket Conservation Foundation filed as a claimant also including the Georges Bank as a coclaimant [64]. A coalition of New England fishing interests also filed as a claimant alleging, among other things, that their livelihood and future livelihood had been or might be affected by the oil spill [65].*

These claims were all filed in the action involving Thebes Shipping Company's petition to limit its liability, although several of the above claimants sued other parties as well. For example, the New England fishing interest group also filed a suit against George Papadopoulos, Captain of the Argo Merchant; and Continental Insurance Co. also filed suits against Thebes' agents, Ameriship and the Greek holding company of Thebes, Triship.

### *The Arguments of Thebes Shipping Co. and Continental Insurance Co.*

The final briefs of each side of the limitation of liability question were submitted to the U.S. District Court in New York City in early July of 1978 [58, 66–68]. Thebes' major contention, as explained by their attorneys, was that the Argo Merchant stranded solely because of errors in navigation [58,66]. If it could be shown that navigational errors were the sole cause of the accident, Thebes would not be liable for loss or damages. Thebes asserted that it had exercised due diligence to make the vessel seaworthy at the start of the voyage, so is not liable. Finally, Thebes asserted that all the the events leading to the stranding were not in the privity and knowledge of Thebes. In summary they concluded [58]:

> The stranding resulted from errors in navigation and not from any unseaworthy condition of [A' 'O] MERCHANT. Thebes exercised due diligence to make the vessel seaworthy at the commencement of her last voyage. Under the terms and conditions of the charter party and the applicable statutes, Thebes is entitled to exoneration from liability for the claims of Continental and Northeast Petroleum Corporation. The errors in navigation were not within the privity and knowledge of Thebes. Pursuant to 46 U.S.C. SS183-189, Thebes is entitled to limit its liability for the claims of all claimants to zero.

By the time this petition came up for hearings, only Continental Insurance Co. was particularly active in the case. They took the viewpoint that Thebes should not be allowed to limit their liability. Continental also submitted briefs to the Court explaining this opposition viewpoint [67,68].

Continental's main point was that the Argo Merchant was unseaworthy with respect to several navigational equipment aspects and that this unseaworthy condition was a contributing cause of the accident. Finally Con-

*At the time these claims had to be filed, little ecological damage assessment research had been done, so the initial claims had to present the worst possible case.

tinental pointed out that Thebes had further failed to exercise due diligence in that Thebes failed to provide the ship with up-to-date charts.

In its reply brief, Continental concluded [68]:

> In this age of supertankers, TORREY CANYON, ARGO MERCHANT, and AMOCO CADIZ disasters, when the carriage of dangerous cargo is the rule rather than the exception, the courts must insist, for the protection of the general public, that a vessel owner exercise due diligence to make certain that its vessels are properly equipped and maintained.

On February 7, 1980, Judge Thomas P. Griesa of the U.S. District Court in New York City rejected the petition of Thebes Shipping to limit its liability [68a]. Judge Griesa found that the owners of the Argo Merchant had not exercised due diligence to make the vessel seaworthy before the last voyage in several aspects. From the testimony, it was difficult to decide whether problems relating to the ship's gyrocompass were caused by equipment failure or improper use of the instrument. The judge ruled that "whatever problem or practice was occurring with the gyrocompass on the final voyage had occurred on previous voyages" [68a]. He further cited precedent which stated that a vessel may be made unseaworthy, not only by a physical condition, but by improper navigational practice. The deck logs for earlier voyages were in the possession of the owner. Judge Griesa stated in his opinion that these improper practices "would have caused any prudent shipowner to make a thorough inquiry as to the condition and operation of the gyrocompass and to take corrective actions. The owner did nothing of this nature" [68a].

Judge Griesa ruled that the failure of the radio direction finder (RDF) was also a contributing cause of the grounding and that the owner had not exercised due diligence to maintain and calibrate the RDF. (There was convincing testimony that the cables should have been replaced in 1975.) The court further ruled that the lack of a current pilot chart was an unseaworthy condition which was a concurrent cause of the grounding, and that the shipowner failed to demonstrate it took reasonable means to provide the ship with up-to-date charts [68a].

Continental contended that the Argo Merchant was unseaworthy in failing to have LORAN. The Court rejected this contention stating that the ship had "sufficient navigational devices if they had been maintained in good order and properly used" [68a].

In his opinion, Judge Griesa concluded [68a]:

> The Argo Merchant was a grossly mismanaged vessel. There were irregular and slipshod navigation practices. There were serious deficiencies in the equipment. Although there were frequent superficial repairs in various ports, there was no thorough-going systematic effort to prevent the use of worn-out and obsolete equipment. The owners failed even to ensure that up-to-date charts were in use on the ship . . . . The causes of the grounding were general mismanagement and neglect by the owner, combined with navigation errors of the officers during the voyage. The owner is not entitled to exoneration from liability under the Carriage of Goods by Sea Act.

The U.S. District Court has thus ruled that the Argo Merchant was unseaworthy with respect to maintenance and ensuring proper use of the ship's navigational instrumentation and that this condition was a contributing cause of the grounding. The Liberian government through its Marine Board of Investigation found that the ship's officers made a number of navigational and judgment errors which also were contributing causes of the grounding [69]. The Liberians thus revoked the license of the master of the Argo Merchant, George Papadopoulos, and suspended the licenses of the chief mate and second mate for four years and nine months, respectively.

The day before the ruling of the court on the liability petition of Thebes, Thebes settled out of court with Continental. A newspaper report indicated this settlement to be approximately $1 million but this amount could not be confirmed by the lawyers involved. Northeast Petroleum was never involved in any legal action regarding its role in the affair, so they do not plan any further action as a result of Griesa's ruling [63]. Therefore, at the time of this writing, only the suits filed against Thebes for damages to the environment are still pending.

### Litigation Concerned with Damage to the Environment

The two suits mentioned previously that deal with damage of the Argo Merchant cargo on the marine environment, both including damage to the seabed are still pending. The complaint of Jay Lanzillo (Cape Cod Commercial Fishermen's Coalition) et al. vs Thebes Shipping Co. is a class action suit involving commercial fishermen, commercial boat owners, commercial wholesale fish dealers, charter fishing boat owners and operators, sport fishermen and noncommercial fishermen. They asserted [65]:

> On reaching the aforesaid areas [fishing grounds, etc.] said cargo interfered with navigation and fishing, destroyed marine species within the waters, damaged and destroyed personal property, polluted tidal and shelf lands and permanently polluted and destroyed shellfish beds, fishing areas, and spawning grounds.

They demanded, among other things, that the representatives of the class be awarded judgment against Thebes for the amount of $50 million to be placed in trust for the benefit of the members of the class. In addition, they wanted punitive damages in the amount of $10 million to be placed in this trust.

A novel approach to the problem of pursuing litigation for damages to the environment is attempted in the complaint of the Nantucket Conservation Foundation, Inc. et al. vs Thebes Shipping Co [64]. In this suit, Georges Bank and all the creatures thereon were listed as coplaintiffs in the action. The right of a natural thing to sue a polluter has been proposed and discussed by Stone [70]. The concept had never been tried, so no ruling has been made.

At this point, the two parties are deciding whether to proceed with their suits on the basis of the data concerning damage to the environment which has been compiled since their suits were originally filed.

## LEGISLATION IN THE WAKE OF THE ARGO MERCHANT

The Argo Merchant oil spill awakened public interest, especially in New England, on the problems associated with the transportation of oil. We have already discussed the litigation that emanated from the spill. There was, in addition, a great deal of unhappiness about the government's response to this spill in particular and oil spills in general. What could the government have done to prevent this oil spill? Did the government do everything it could to attempt to clean up the spill? Was the oil spill and its ecological impact effectively studied by the government? This section will discuss the governmental response to the spill and the changes in legislation and procedures that came about after the accident.

### Impact of the Argo Merchant Oil Spill on U.S. Government Procedures, Regulations and Legislation

*Prevention of Oil Spills*

The need for stricter tanker safety standards was recognized by international and U.S. experts long before the Argo Merchant oil spill. In fact, two multilateral international conventions, the International Convention for Safety of Life at Sea (SOLAS, 1974) and the International Convention for Prevention of Pollution from Ships (1973) had been drafted by the Intergovernmental Maritime Consultative Organization (IMCO), an agency of the United Nations. At the time of the Argo Merchant, and at the time of this writing, neither had been ratified by the U.S., as the Senate felt the regulations were still too lenient.

Subsequent to the Argo Merchant, and the rash of tanker accidents shortly thereafter, the U.S. Government took action on several fronts. Another IMCO convention was called to draft stricter regulations; unilateral legislation by the U.S. was enacted with stricter minimum standards and authorizing the U.S. Coast Guard to issue any needed standards by regulation; using powers already given it by legislation the Coast Guard greatly expanded its enforcement activities and NOAA- and EPA-constructed contingency plans for oil spill scientific research.

At the time of the Argo Merchant spill, the U.S. Coast Guard already had the power by U.S. legislation and international conventions to inspect tanker vessel from foreign countries doing business in U.S. ports. Thus, after this and the subsequent tanker accidents on January 21, 1977, the USCG greatly expanded its program of boarding of foreign flag tankers [71]. Congress re-

sponded by increasing the Coast Guard's appropriations to reflect the expanded program [72]. The data developed by the Coast Guard in their tanker inspection program for its first two years of operation show that there has been a general improvement in the overall safety level to those foreign vessels involved in the program [73].

The Coast Guard has had the authority to impose stricter tanker safety standards since the Ports and Waterways Safety Act of 1972. Traditionally, the Coast Guard (or State Department) had been unwilling to impose standards stricter than those imposed by international conventions [74] because it was felt that such unilateral action might damage international relations with other seafaring nations [75]. At the time Argo Merchant made her final voyage, neither radar nor gyrocompass requirements were in force either by regulation or international convention. Anticipating ratification of the SOLAS (1974) and Pollution (1973) IMCO conventions by the U.S. Senate, the Coast Guard gave advance notice in 1973 that similar standards would be proposed by the U.S. to implement these international agreements. These regulations were formally proposed in May, 1976. Because the two international treaties, as yet unratified by the U.S., also require additional navigation equipment and improved cargo handling procedures, the Administration felt that the earlier adoption of these regulations by the United States would show other maritime nations the willingness of the U.S. to adopt these procedures, even though the multinational treaties themselves have not been ratified. Only coincidentally did these new regulations go into effect in January 1977, weeks after the Argo Merchant accident.

The regulation-making process within the federal Government is very slow, an attribute not only of the Coast Guard. In this particular case, the law granting regulatory powers was enacted in 1972, and the first set of regulations did not go into effect until 1977. But after the Argo Merchant spill the President expressed his concern about the risks associated with marine transportation of oil and directed the Secretary of Transportation to propose new rules and expedite regulatory procedures for increased standards of domestic and foreign vessels entering U.S. ports [76]. At present, the rule-making process now appears to be proceeding at a faster rate.

The Coast Guard had already started issuing stricter regulations prior to the Argo Merchant accident and, pursuant to the President's directive, began further rule-making proceedings. But the U.S. Congress felt that further legislation was required in the general area of tanker safety. The result of their deliberations was the Port and Tanker Safety Act of 1978 [77], introduced to the Senate on February 10, 1977, two months after the Argo Merchant. We will discuss only those sections of the act influenced directly by the Argo Merchant.

In the Congressional hearings held to evaluate this act, several referrals to the Argo Merchant were made concerning several of the sections. The site of Argo Merchant's demise was 27 miles off the U.S. coast and was outside U.S. waters as defined in previous acts. While Congress did not adopt the 200-mile

"Maritime Safety Zone" concept as suggested in one of the original bills [78], it did define the term "marine environment" as follows [77]:

> 'Marine environment' means the navigable waters of the United States and the land and resources therein and thereunder; the water and fisheries resources of any area over which the United States asserts exclusive fishery management authority; the seabed and subsoil of the Outer Continental Shelf of the United States, the resources thereof and the waters superjacent thereto; and the recreational, economic, and scenic values of such waters and resources.

This concept gained wider acceptance than did the Clean Water Act amendments of 1977, which did not specifically exclude ships passing through the 200-mile zone but not destined for a U.S. port [79].

The Coast Guard did take over control of the Argo Merchant even though she was outside the territorial sea through invocation of the Intervention Convention of 1969 (effective 1975). Thus, the Port and Tanker Safety Act of 1978 [77] provides no improvement over what was in force in December of 1976 in terms of the powers available to the Coast Guard regarding post-accident actions; however, it does increase the Coast Guard's jurisdiction to take preventive action within 200 miles of the U.S. coast, i.e., inspections, mandatory use of shipping lane approaches, etc.

The Ports and Tanker Safety Act of 1978 also instructs the Administration to establish vessel traffic services if the Secretary of Transportation determines the area is hazardous, congested with vessels or prone to adverse weather conditions. These vessel traffic services are similar in design as air traffic services at airports. Such vessel traffic service has already been set up in New Orleans, Houston, San Francisco Bay and Seattle. At present, only in Seattle is compliance with the service mandatory. In addition to traffic services, the Act also instructs the Secretary of Transportation to study the feasibility and desirability of systems for monitoring the position of vessels (including fishing vessels) within the Fishery Conservation Zone using either a land, sea or space monitoring technique [77]. This report is due to go before Congress in 1980. If such a monitoring scheme had been adopted and operational in December of 1976, the crew of the Argo Merchant could have been warned before it proceeded so far into shoal waters. The necessity of monitoring is further illustrated by the grounding of the tanker Afghanistan on Nantucket Shoals in 1978 and the collision of a freighter and another tanker in fog in the same area in 1979.

### *Oil Spill Liability and Compensation*

Before the Torrey Canyon accident in 1967, no adequate national or international legal regimes existed to compensate victims of oil pollution damage or to enable governments to recover costs incurred in cleaning up spills [80]. Voluntary agreements among tanker and oil industries—TOVALOP (Tanker

Owners Voluntary Agreement Concerning Liability for Oil Pollution) and CRISTAL (Contract regarding an interim supplement to Tanker Liability for Oil Pollution)—were adopted in 1969 and 1971, respectively, to provide a means of compensating for pollution damage until the IMCO (Intergovernmental Maritime Consultative Organization) compensation schemes, CLC (International Convention on Civil Liability for Oil Pollution Damage, 1969) and the Fund Convention (International Fund for Oil Pollution Damage, 1971) went into effect. Even though the IMCO convention CLC went into force in 1975, it has been ratified by only 36 nations, so TOVALOP and CRISTAL are still necessary to provide compensation for damages in coastal waters of unratified nations. (The U.S. has not yet ratified this convention. See Carven [80] for a discussion of these agreements and conventions.)

Limited oil spill compensation plans were enacted by Congress as early as 1973, where it was incorporated in the Trans-Alaskan Pipeline Authorization Act of 1973 [81]. Recovery for damages of spills was also covered in the Deepwater Port Act of 1974 [82]. Comprehensive legislation to remedy the patchwork approach to oil spill compensation was first introduced in 1975 [83] and again in 1976, but at neither time was it passed. Again this legislation, nicknamed "Superfund," was introduced and in the wake of the Argo Merchant, President Carter urged passage of a uniform oil pollution compensation and liability bill. This time the legislation progressed further than ever, passing the House and being reported out of committee by the Senate. It will be introduced yet again in the current session of Congress.

There are two aspects of this proposed legislation that would have had an impact on the Argo Merchant situation. In the case of the Argo Merchant, to collect for any damages the claimants had to prove that the owner was negligent (see p. 202) or perhaps recover damages from TOVALOP or CRISTAL where applicable. (At the time of the Argo Merchant, TOVALOP covered cleanup costs; as of 1978, however, it includes compensation for pollution damage also.) Proving negligence is difficult and also involves lengthy legal procedures. In this legislation, claimants under "superfund" would no longer need to prove that the spill was the result of a negligent act of the vessel or facility. As explained by Couper [84]:

> The spiller would be notified by the Secretary of Transportation that he is the 'designated source' of oil pollution, and unless the designation is denied, the spiller would begin advertising procedures for submitting claims and begin accepting claims and negotiating settlements for resultant oil pollution damages. Liability of the designated source does not depend on proof of negligence.

The other application of this proposed legislation to the Argo Merchant-like situation are provisions where the fund would pay for damage assessment studies to be undertaken as a part of claims adjustment for major oil spills. This will solve the problem of funding for future ecological damage assess-

ment studies. A further discussion of the provisions and history of this proposed legislation is available in the literature [84,85].

*Toward Improving the Government's Response After Spills*

The federal government's response to the Argo Merchant oil spill, its efforts to prevent loss of the cargo after the accident, and its efforts to study the effects of the spill drew heavy criticism from all levels directed at all levels. Congress was criticized for failure to ratify the international agreements, and impose stricter laws involving tanker safety [86]. The Coast Guard was criticized for slowness of response [86], failure to consult with state governments potentially affected by the spill [87] and failure to issue tighter tanker regulations authorized by the prior laws [73]. NOAA and EPA were criticized for lack of leadership in the afterspill ecological response [88], lack of funding to support adequate research [50,86,89,90], and lack of planning [86,89]. Woods Hole Oceanographic Institution and the University of Rhode Island were criticized on specific scientific questions [92]. We have already discussed some of the actions the Congress and the Coast Guard took in response to public clamor. This section will examine the changes that have occurred since the Argo Merchant spill concerning spill response by agencies within the federal government.

Real progress has been made in several aspects of spill response. The administration of the state of Massachusetts was very upset during the first phases of the federal response to the Argo Merchant. Among the complaints was that the federal government failed to notify Massachusetts about the potential of a large oil spill so that the state could take whatever actions it could to protect sensitive shoreline areas if necessary [93]. After Argo Merchant experiences, at the recommendations of Massachusetts, the National and Regional Response Teams were restructured to allow greater participation by the affected state [87].

In addition to the criticisms leveled at the Regional Response Team whose duties then were primarily to oversee the cleanup operation, there were similar problems in the scientific studies of the spill. As mentioned previously, seven federal agencies (from 29 different offices), four state agencies and seven universities and private institutions participated in scientific studies of the spill. One of the foremost problems was lack of timely funding. As later stated by Dr. Wilmot Hess [94]:

> The Argo Merchant also demonstrated that the scientific community in the area which an incident occurs can provide essential expertise and capabilities and should be so utilized. Many scientists in the area were experienced in the study of oil spills or in hydrocarbon research. Participation in the Argo Merchant incident, however, resulted in their being diverted from their ongoing research, much of which is sponsored by general grants and contracts. While funding was obtained from the Department of Commerce and Department of the Interior for initial assessment purposes, the delays in determining the

sources and amount or resources available did impact the timing of the investigations and the involvement of the scientific community.

In addition to the lack of sufficient timely funding, there was a lack of advance planning for spill response. The need for such a plan had been advocated before the Argo Merchant in a workshop held by EPA in 1975 [95]. Also a workshop held by API in early 1976 outlined strategies and techniques recommended for use in event of an oil spill [96]. The API recommendations were published, however, after the Argo Merchant. Thus, the only group that had any plan or organization prior to the spill was the NOAA-SOR Team, whose main thrust was the behavior of the surface oil. There was no published adopted plan or organized team for ecological damage assessment. Therefore, such a plan had to be hastily constructed for the ecological damage assessment program following the Argo Merchant.

Eventually there were three such plans devised for ecological studies following the spill. The first of these, the EPA plan, was briefly sketched out at a meeting called by the administrator of EPA held in Boston, December 22, 1976. Another planning session, sponsored by the NOAA-SOR Team and MESA program, was held in Woods Hole, January 3–4, 1977 and the product has later been referred to as the NOAA plan. Because this planning session lasted for two days (instead of two hours), the plan was a great deal more detailed than the EPA plan and even recommended specific collection and analytical procedures to be used. However, the NOAA plan, with its estimated cost of $255,000 for the first cruise, had to be revised before the cruise took place, because the funding actually received by URI from NOAA for this cruise was only $60,000. (Eventually four cruises to the wreck site area were conducted by URI with total NOAA funding of $85,000.) Therefore, yet another plan (NOAA-URI plan) had to be devised, this time with the available funding and equipment in mind.

Since the Argo Merchant, great strides have been made in the area of advance planning for oil spill ecological damage assessment studies. To our knowledge, there are now three series of oil spill response plans, each funded or partially funded by three separate groups. At the Argo Merchant oil spill, few, if any, representatives of American oil and shipping industries were present, but then none of the major oil companies or American shipping industries were directly involved. Since then, the American Petroleum Institute has published a suggested oil spill response strategy [96] and several companies have indeed formed oil spill response teams with equipment, funds and personnel identified in advance [97].

The NOAA-SOR Team, formed prior to the Argo Merchant and which studied the behavior of the surface slick, has expanded its operations to include an interest in ecological damage. This program, which has continued with Bureau of Land Management funding, solicited proposals this in November of 1978 [98]. They are particularly interested in studying spills that might help in understanding the behavior of oil in the Alaskan environment.

EPA responded by spearheading an interagency task force to devise regional response plans for ecological damage assessment following spills of oils and hazardous materials, which would interface with the National Contingency Plan (40 CFR 1510; February 10, 1975). The National Contingency Plan at the time of the Argo Merchant primarily dealt with pollution mitigation operations rather than the broader environmental consequences of spills. Under the direction of Dr. Paul Lefcourt of EPA, a series of regional workshops were held to recommend projects that could help in ecological damage assessment. The New England workshop, the first of these workshops, was held in August of 1977 with experts from federal and state governments, academia, industry and environmental companies in attendance. The result of their deliberations has been published recently [99]. The report lists suggested projects and inventories expert personnel in the region and the analytical chemistry facilities and research vessels of the area. In theory, future projects and personnel would be identified in advance for various scenarios and contracts would be issued to go into effect in the event the plan is activated after a spill. Progress to this goal has stopped because the funds to support the ecological damage assessment program were to come from the "superfund" legislation, which did not pass through Congress. So the plan is there, but has not as yet been fully implemented.

In the regional plans, the designation of leadership of the scientific response has also been addressed. This designation is necessary because following the Argo Merchant there was a brief interagency disagreement as to who was actually in charge of the Argo Merchant spill studies. While the leadership aspect was being negotiated, there was actually a leadership void during the earlier stages of the spill [100]. The regional response plan now states the NOAA will be the lead agency for scientific studies in the event of offshore spills, while EPA will be the lead agency in inshore spills [99]. With all of these changes in procedure, the process of oil spill research may not be any easier in the future, but it will proceed with less confusion.

### Rhode Island and Massachusetts: Impacts on State Procedures and Legislation

As mentioned previously, Massachusetts' state authorities were upset about the federal response to the oil spill. To remedy this situation, the Massachusetts' Executive Office of Environmental Affairs filed a rule-making petition to the U.S. Council for Environmental Quality, which at that time was revising the National Contingency Plan. Among the items requested by Massachusetts later included in the revised plan were the following:

1. The states have the right to become full participating members of the regional response teams with the right to appeal to the National Response Team.
2. EPA and NOAA must provide scientific support coordinators to maximize private sector involvement at both the regional and national levels.
3. Each coastal region must field test its response equipment annually.
4. A response mechanism has been initiated which can notify states when there is a threat of discharge [101].

Rhode Island has embarked on several programs as a result of the public awareness and increased concern about oil spills. After the Argo Merchant, the R. I. Coastal Resources Management Council has compiled a list of sensitive coastal areas within the state. To accompany this list are ideas on how to protect each area should a spill occur. For example, there are several coastal ponds that are open to the ocean only at narrow breachways. If an oil spill were to threaten such an area, it would be possible to fill in the breachway with sand; then, when the threat was over, the breachway could be reopened. The R. I. Coastal Resources Management Council is also drafting a proposal to inventory all the earth-moving equipment in the state (private, city, town or state owned) which could be mobilized in this event. Under this proposal, each town would handle protection of ponds in its own borders, calling on neighboring towns if it needed help, much the way towns cooperate with fire protection [102].

At present, both Rhode Island and Massachusetts are drafting oil spill compensation and liability bills to fill in the gaps left by international and congressional action [103].

## SUMMARY

We would have to agree with the headlines of a *Science* article one year after the spill: "Oil in the ocean: circumstances control its impact" [104]. The natural circumstances in the Argo Merchant case were offshore winds, turbulent seas and a shallow sandy bottom that was scoured by swift tidal currents. The offshore winds pushed the large majority of the oil, the surface slick, out to the open ocean where it presumably became a part of the inventory of open ocean petroleum hydrocarbons and tar balls. The sediments of the area were sandy and the oil did not adhere well to the sand grains. The sediments were observed to release small oil droplets into the water column on agitation. Certainly all of these factors tended to have a mitigating effect on the environmental impact. While there were observable short-term effects and possible longer term impacts suggested, the environmental impact was minimal in comparison to other well-studied spills, or in comparison to what could have happened if the oil had gone inshore.

As early as three months after the spill, a wise sage remarked to us, "the impact of the Argo Merchant spill is largely political" [105]. Due to the extensive media coverage of the Argo Merchant event and the similar tanker accidents that followed soon after, the risks associated with the marine transportation of oil were made known to the public. Even though the specifics of these accidents were not long remembered, more than three-quarters of people surveyed one year after the spill thought they knew of some of the effects of the Argo Merchant spill [106]. Politicians from all levels demanded action. The net result was a greatly expanded U.S. Coast Guard tanker boarding and inspection program; passage of the Ports and Tanker Safety Act of 1978; increased support of the U.S. for stricter tanker regulations in international

agreements; more concern about owner liability and oil spill compensation problems; and passage of the National Ocean Pollution Research and Development and Monitoring Act of 1978 [107], which authorized a coordinated program to study the entire problem of pollution of the oceans. The Argo Merchant oil spill may not have been the biggest off the U.S. coast [108], as originally reported, and its environmental consequences were certainly not as disasterous as originally predicted, but its impact on public awareness and government procedures was both considerable and positive.

## ACKNOWLEDGMENTS

This work was supported by EPA Grant R805477020 and NOAA Contract 03-7-022-35123. We wish to thank several members of the URI Oil Spill Response Team and cooperating investigators whose individual research efforts were interwoven in this paper: Sheldon Pratt, Peter Cornillon, Robert Brown, Chris Brown, Audrey Filion, Renate Polak, Richard Jadamec, and Scott Fortier. We further thank the following people for their helpful suggestions: William Ecker, USCG; Frank O'Regan, attorney; Frank O'Rourke, attorney; John Lyons, R. I. Coastal Resources; William Sutherland, USCG, Leon Kazmierczak, Sun Co., and Ken Morse, Pell Marine Science Library.

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